NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
PATUXENT RIVER, MARYLAND

TECHNICAL INFORMATION MEMORANDUM

REPORT NO: NAWCADPAX/TIM-2016/49

HIGH-FREQUENCY AXIAL FATIGUE TEST PROCEEEDURES FOR SPECTRUM LOADING

by

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20 July 2016

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
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RELEASED BY:

20 July 2016

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REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
20 July 2016	Technical Information Memorandum	

4. TITLE AND SUBTITLE High-Frequency Axial Fatigue Test Procedures for Spectrum Loading	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) David T. Rusk Robert E. Taylor	5d. PROJECT NUMBER 219BAR-10-008 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Air Warfare Center Aircraft Division Code 4.3, Bldg. 2187 48110 Shaw Road, Patuxent River, MD 20670	8. PERFORMING ORGANIZATION REPORT NUMBER NAWCADPAX/TIM-2016/49
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Air Systems Command (CTO) 47123 Buse Road Patuxent River, MD 20670-1547	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This Memorandum documents the procedures for conducting an axial fatigue test under variable amplitude (spectrum) loading conditions using an MTS 810 High-Frequency Test frame. Load-controlled fatigue testing under repeating block, variable amplitude loading histories can be performed at frequencies much higher than standard servo-hydraulic test frames by using a test frame that is optimized to run at higher frequencies. AIR 4.3 has conducted a research program to develop a test capability for performing such tests, using an existing MTS 810 test frame operated in servo-hydraulic mode. The test frame configuration was modified to maximize controller response during variable amplitude loading, and a closed-loop digital test frame controller with a command feedback compensation scheme was used to minimize controller error during testing.

15. SUBJECT TERMS

High Frequency Fatigue, Fatigue Testing, Stress Life, Load Spectrum, Endurance Limit, Command Feedback

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON David Rusk
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (include area code)
Unclassified	Unclassified	Unclassified	SAR	31	301 342-9428

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

SUMMARY

The purpose of this Memorandum is to document the procedures for conducting an axial fatigue test under variable amplitude (spectrum) loading conditions using an MTS® 810 High-Frequency Test frame. Load-controlled fatigue testing under repeating block, variable amplitude loading histories can be performed at frequencies much higher than standard servo-hydraulic test frames by using a test frame that is optimized to run at higher frequencies. AIR 4.3 has conducted a research program to develop a test capability for performing such tests using an existing MTS® 810 test frame operated in servo-hydraulic mode. The test frame configuration was modified to maximize controller response during variable amplitude loading, and a closed-loop digital test frame controller with a command feedback compensation scheme was used to minimize controller error during testing. The procedures used to set up and test an axial fatigue specimen to failure for this test equipment are described in this report.

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INTRODUCTION

BACKGROUND

1. Application of Ultra-High Cycle Fatigue (gigacycle) testing capabilities has shown that a true fatigue endurance limit (infinite life) does not exist for most metallic materials used in high cycle applications. In fact, such research has shown that for many materials, the critical crack nucleating mechanisms may change as a very large number of low-amplitude cycles are accumulated that are below the traditionally assumed endurance limit. Crack initiation at the specimen surface is the typical failure mechanism in nearly all ductile metallic materials that are fatigue tested to a 10^7 cycle runout limit. However, fatigue failures beyond 10^7 cycles can be caused by several competing failure mechanisms and may result in a transition from surface dominated crack nucleation sites to subsurface dominated for some material types. Variable amplitude loading of the type seen by airframe structural and dynamic components further complicates the picture, as small and large amplitude fatigue cycles and mean stresses may have different effects on the competing failure mechanisms in the material. For these reasons, it is necessary to have the ability to conduct fatigue testing under variable amplitude loading that is representative of airframe loads spectra, and at testing speeds that will allow the investigation of fatigue failures beyond the traditional 10^7 cycle runout limit.

PURPOSE

2. To develop the capability to perform High-Frequency (H-F) Spectrum Fatigue tests, an in-house Basic and Applied Research (BAR) program (219BAR-10-008) was initiated in 2010. The program investigated the influence of a generic rotorcraft main rotor blade root bending spectrum (Helix) on the crack nucleation mechanisms in 7075-T651 aluminum. Tests were performed that generated fatigue failures out to nearly 10^9 cycles. This program used available test frame equipment that was modified to maximize controller response during variable amplitude loading. A basic description of the test protocol and initial test results are listed in reference 1. Detailed procedures to set up the test frame, load test specimens, tune the test controller to minimize command feedback loop error and calculate resulting fatigue damage accumulation error were all developed as part of this BAR program. The detailed procedures are documented in this report.

3. The objective of any H-F Spectrum Fatigue test is to perform the test at the highest possible frequency allowed by the test equipment and test configuration in order to minimize total test time, while staying within some pre-established margin for damage accumulation error. Damage accumulation error is the result of errors in Peak-Valley (P-V) response of the test specimen to the command input signal for load cycling. These cycle-by-cycle errors accumulate over the life of the test specimen to cause a difference in the failure life that the test specimen experiences vs. what the failure life would have been if the test had been perfectly controlled. The test procedures here have been developed to minimize this type of error over the duration of an individual fatigue test, and for a group of fatigue tests being performed using the same test parameters.

DESCRIPTION OF EQUIPMENT

4. The test frame is an MTS® 810 High-Frequency Test System, which can be configured for use with standard or voice-coil servo-valves. Only standard servo-valves were used for this type of HF test. Three different servo-valve configurations have been utilized for this testing: single, dual, and quad servo configurations. Servo-values used were MTS® 252.43G.01. For the dual and quad servo configurations, a custom manifold was designed and fabricated to mate to the existing hydraulic inlet ports on the test frame and to minimize the fluid path distances from the servo-valves to the actuator. The quad servo configuration was used in the most recent HF tests, and all of the setup and tuning descriptions in this report are referenced to that specific servo configuration. Standard MTS® 647.02B hydraulic wedge grips are used, with MTS® Surfalloy 1 in. dia. round specimen wedges grip inserts suitable for holding test specimens with round grip sections. A 25 kN (5.5 kip) load cell was used with a 22.7 kN (5 kip) calibration range. An MTS® 609.10A-01 alignment collar connects the load cell with the crosshead on the test frame. The test frame is enclosed in a sound deadening room with a door that can be closed during testing. The room has a small air conditioner to maintain ambient temperature in the range of 72-85°F during testing. The test controller is an MTS® FlexTest SE digital controller. Test control software is 793, and is hosted on a @XI PC with a 2.3 GHz processor 8 GB RAM running the Windows 7 SP1 operating system. The control software has toolboxes enabled for different command feedback compensation schemes. Display equipment consists of a Nicolet 4562 oscilloscope with window capturing capability.

METHODS

DISCUSSION

TEST PROCEDURES

5. Test Specimen Preparation: Fatigue test specimens used in this H-F testing apparatus should conform to ASTM E606/E606M-12 recommendations for axial fatigue test specimen geometry (reference 2). The test procedures assume the use of axial round bar specimens in uniform or hourglass gauge section geometries. Only the straight-sided collet grip end configurations have been investigated for this test setup. H-F tests using flat sheet specimens could also be performed using these test procedures; however, that would require using grip inserts suitable for flat grip tabs. That configuration has not been tested for the H-F test setup defined here. Test specimens should be fabricated with particular attention to surface finish, as the fatigue test results at very long lives can be highly sensitive to minor surface imperfections that serve as crack nucleation sites. This also depends on the type of material being tested. Residual stresses in the test specimen gauge section can also have a major impact on the fatigue test results. Small surface residual stresses of 10 ksi or less can reduce fatigue life by several orders of magnitude because the slope of the Stress-Life (S-N) curve can be very shallow in the long life regime (Figure 1). It is recommended that surface residual stress measurements are taken at several points in the gauge section, and on more than one specimen, to verify that a consistent level of residual stress is being produced by the specimen manufacturing process. Before installing the test specimen in the test frame, a 25.4 mm (1.0 in.) diameter spacer, made of linen-phenolic composite, is press-fit onto the specimen grip sections to isolate the specimen from contact with the hydraulic grip wedges. This has proven to significantly reduce instances of premature failure in the specimen grip sections at large numbers of accumulated test cycles.

6. Test Frame Alignment and Calibration: Load train alignment on the test frame should be performed in accordance with ASTM E1012-14 (reference 3). Load transducer calibration range should be selected to be close to the maximum and minimum test loads in the fatigue spectrum to maximize the sensitivity and minimize the measurement error of the loading history throughout the test.

7. Test Frequency Sweep: The resonant frequencies of the test specimen, load train, and test frame can cause significant difficulties with controllability if the testing frequency is sufficiently close to any of the resonant frequencies. To determine if this will be a problem for the configuration that will be tested under spectrum loading, a frequency sweep from 50-300 Hz should be performed prior to starting spectrum load testing. The sweep should be run using a constant amplitude, sine wave loading (R=0.1) waveform with P-V compensation enabled. Testing should start at 50 Hz and proceed to 300 Hz in 10 Hz increments with sufficient dwell time at each frequency to stabilize and record the P-V error over an interval of cycles. Post-test analysis of the recorded data should show that the test system as configured was able to provide stable control with a consistent level of P-V error for all frequencies tested.

8. Test Controller Setup: All tests are programed using MPT (MultiPurpose TestWare) found in Station Manager under Applications (Figure 2). The Command Feedback Compensation

scheme used for the spectrum test should be Arbitrary End-Level Compensation (ALC) (reference 4), as this has been shown to provide the least amount of P-V response error in previous sensitivity studies (reference 1). The spectrum test should be load controlled, and run under constant frequency control using a sinusoidal waveform. Initial test frequency should be chosen to provide close, stable control over the full range of the spectrum loading block—especially in block sections with the greatest amount of P-V range and mean variation from cycle to cycle. No signal conditioning should be applied to the load cell output, to eliminate the possibility of analog bandwidth limitations affecting the controller feedback loop. The basic data rate of the test controller should be obtained from the manufacturer, and should be verified by writing the load cell signal response to a file at the maximum data rate available in the control software along with the elapsed time for each data point. This data should be collected prior to the start of spectrum testing, and any deficiency in the measured data rate should be investigated and corrected. Noise in the load transducer signal may affect the P-V response error during testing. This error can be quantified by recording load cell response with a test specimen at zero load and at a static tension load close to the peak tensile load in the spectrum. Load cell output should be recorded at the highest possible data rate with enough duration (10 sec. minimum) to provide a statistically significant minimum sample size of 5,000-10,000 samples at each load level. The recorded data should be fit to a Gaussian distribution to extract the mean and standard deviation of the noise response at each load level. Transducer noise error should be significantly less than the maximum static calibration error measured during load cell calibration as defined by ASTM E04-14 (reference 5). If the noise error as defined by 3x the measured standard deviation is equal to or greater than the calibration error, steps should be taken to reduce the transducer signal noise prior to the start of fatigue testing. Detailed instructions for installing a test specimen in the test frame are listed in Appendix A. Step-by-step instructions for setup, initialization, and execution of a spectrum test are listed in Appendix B.

9. Test Controller Tuning: Detailed instructions for test controller tuning are listed in Appendix C, as the system controller must be tuned manually when running spectrum tests with ALC compensation.

10. Test Data Recording: Instructions for setup of the data recording options in the test frame controller software are listed in Appendix D. Special considerations that must be accounted for when collecting HF Spectrum test results are defined here. Using command feedback compensation can cause significant phase shifts in command and load responses at high frequency. Therefore, the output data streams from the spectrum command and response signals must be written to separate files to ensure that independent P-V triggers are being used for each data channel. Test specimen temperatures must be periodically monitored to ensure that they do not deviate significantly from the target temperature range for the test. Combinations of large amplitude load levels and high test frequencies have been shown to generate the greatest temperature rises in test specimens subjected to long duration fatigue testing. Active cooling of the test specimen and/or grips may be necessary to stay within the defined test temperature range at high frequencies.

11. P-V Measurement Error: The P-V load response data recorded by the test frame controller is subject to errors generated by the electrical measurement system used in the test frame. These errors contribute to the damage accumulation errors that the test specimen sees over the duration

of the test, as well as to the calculated values of damage accumulation error estimated from the recorded test data output. As such, these errors need to be quantified to assess whether the test falls within the acceptable range of damage accumulation error stated in the test objectives. ASTM E1942-98 gives instructions for assessing the level of error in the electrical measurement system (reference 6). The basic data rate of the test controller should be provided by the manufacturer and should have been verified prior to spectrum testing. Reference 6 gives minimum data rate and maximum amplitude error recommendations. These recommendations may be exceeded at high test frequencies and should not be considered the limiting factor for maximum achievable test frequency. However, actual error experienced during the test must be factored into the damage accumulation error calculations to determine if the measured load response exceeds the damage accumulation error limits proscribed in the test objectives.

12. Damage Accumulation Error Calculation: The purpose of close control of the spectrum fatigue test is to ensure that fatigue damage that causes the test specimen to fail can be accurately described by the loading history input to the specimen by the load frame. Significant deviations in load response from the load command input signal will result in a test failure that will not match the predicted failure range because the accumulated damage on the test specimen will be different than what is input to the fatigue life model. It is expected that the cycle-by-cycle P-V error may vary substantially depending on the load spectrum content, the compensation scheme utilized and the individual cycles preceding and following the current cycle. However, the influence that these cycle-by-cycle errors have on the final results of a spectrum loaded fatigue test are difficult to determine based solely on range, amplitude, or mean stress errors in the measured loading response, which are the parameters generally used to perform real-time tuning of the test frame controller. It is therefore necessary to calculate the damage accumulation error of a test specimen during initial test tuning, and periodically during the test, to verify that the accumulated P-V errors do not cause the damage accumulation error to exceed the target test value. To calculate Damage Accumulation Error, a High-Cycle Fatigue (HCF) Stress-Life (S-N) curve must be defined for the material being tested. For fatigue lives less than 10^6 cycles, standard HCF curve shapes can be used. For fatigue lives greater than 10^6 cycles, log-linear or log-log extrapolations of finite life out to very long fatigue lives (10^{15}+ cycles) must be made. These extrapolated life curves should be based on available constant-amplitude fatigue tests that are conducted in the Ultra-High-Cycle Fatigue region (> 10^7 cycles). If this type of data is not available for the material being tested, then the curve shapes must be estimated from data for similar classes of material. The slope of this life curve defines the sensitivity of the damage accumulation error to P-V errors in small-amplitude cycles. If the slope of the life curve is shallow, P-V errors in small-amplitude cycles will have much less contribution to the damage accumulation error than if the life curve is steeply sloped.

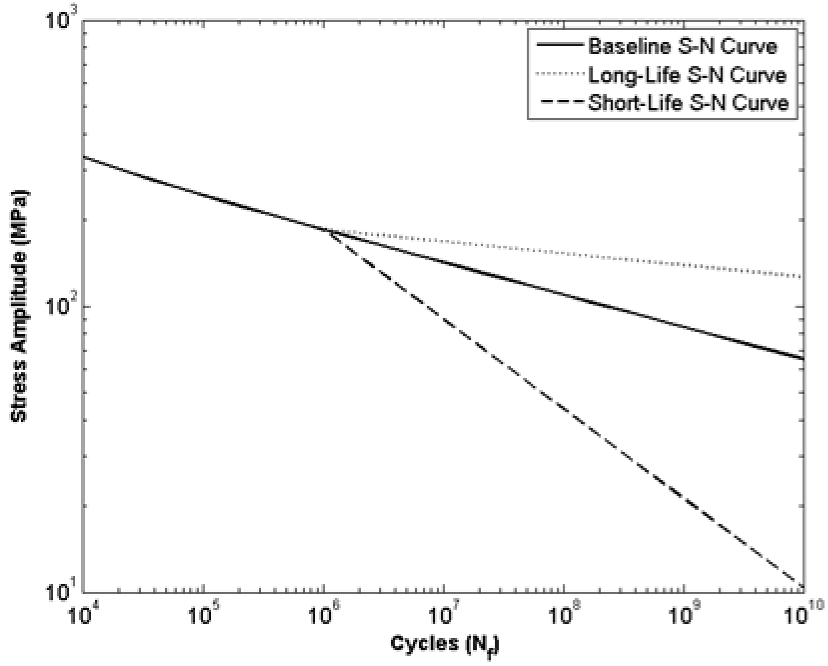

Figure 1: Giga-Cycle S-N Curves for a Material in the HCF Region

13. The spectrum load history must be cycle counted prior to calculating damage fractions. Rainflow cycle counting is the standard method of cycle counting used for fatigue life estimation algorithms. The method developed by Glinka and Kam has proven to be robust for a wide range of spectrum types (reference 7). The method outlined in ASTM E1049 can also be used, but it requires that the spectrum be rearranged to start with the maximum peak value (reference 8). For damage accumulation error calculations, the recorded command input history and the load output history must be cycle counted separately. A check must be performed to verify that the command input history and load output history start and end at the same load cycles in the spectrum file. This will ensure that the damage fraction calculations contain the same nominal cycle counts and content for both recorded histories. Ideally, the output for a complete pass through the spectrum block will be recorded for damage fraction calculations, but this may be difficult to do for very long spectrum block files. The alternative is to record a section of the spectrum block output, and use this to estimate the damage fraction content of an entire spectrum pass. Care must be taken to ensure that the fraction of the spectrum block that is recorded captures the full range of P-V range, amplitude and mean stress variation in the full spectrum, or the damage fraction calculations may not be representative of the P-V errors encountered over the duration of the test.

14. The cycle counted command and load response output must be corrected for mean stress effects prior to damage calculation. Smith-Watson-Topper (SWT) is the preferred method of mean stress correction, as it gives more accurate equivalent stress values than other methods for a wide range of material types (reference 9). The damage fractions for the mean stress corrected rainflow cycles of each output stream are interpolated from the S-N curve, and the cumulative damage fraction for the complete spectrum output stream is summed using the Palmgren-Miner linear damage accumulation rule (reference 10), where n is the number of cycles at a defined

equivalent stress level, Nf is the cycles to failure, and Di is the ith damage fraction for an individual load cycle.

$$D_i = \frac{n}{N_f} \tag{1}$$

15. To provide a relative measure of damage accumulation error compared to a target value, a damage ratio parameter (Γ) is defined as the ratio of the cumulative damage fractions for one spectrum pass of the recorded load history response (subscript R) vs. the target command load input (subscript T).

$$\Gamma = \frac{\Sigma D_{iR}}{\Sigma D_{iT}} \tag{2}$$

16. The damage fractions for the recorded command load input and load cell output data streams are summed, and used to calculate the damage ratio parameter just defined. This value represents the average damage accumulation error, conditional on the measurement error of the P-V load response data. The damage accumulation error is assumed to be relatively constant over the duration of the test, but if significant tuning changes are made while the test is in progress, or if a significant increase in output signal error is experienced, this assumption may no longer hold true. In such cases the damage ratios calculated before and after the event can be weighted by the fraction of total life corresponding to each ratio to give an average damage ratio for the full test life.

17. To calculate the unconditional damage accumulation error that is independent of the P-V measurement error, the measurement error must be subtracted from the recorded load history response. This can be done using the Monte Carlo simulation method described in reference 1, where the parameters of the P-V error distributions are defined from the error characterization steps outlined previously in this test procedure. The mean damage accumulation error that is output from the simulation can then be compared to the target error value set for the test program. A reasonable target value for maximum damage accumulation error is approximately ± 5%. If measured damage accumulation error exceeds the target value, the test frequency may need to be reduced to stay within the defined limits. The measured damage accumulation error may also be used to provide additional test frame tuning. Damage fractions for individual cycles in the load history can be output and sorted to determine the percentage of damage that is being done by the few large amplitude cycles vs. the many small amplitude cycles in test spectrum. Subsequent tuning can be targeted to minimize P-V error for the groups of cycles that make the largest contribution to total damage in the fatigue test.

18. Test Results: Data recorded at the end of a test must include the total number of load cycles accumulated on the test specimen, periodic output of the command input signal and load response histories, periodic measurements of test specimen temperature and the final test frequency that was achieved during testing. Tuning parameter settings for the test controller may also be recorded to ease setup for future tests that will be performed and to assist in troubleshooting if control error anomalies appear in subsequent tests.

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APPENDIX A
INSERTING TEST SPECIMEN IN FRAME

1. Start MTS 793 software and open a configuration file. In the Station Manager window (Figure 2), click Reset and Reset/Override, then click HPU to bring on hydraulic pump.

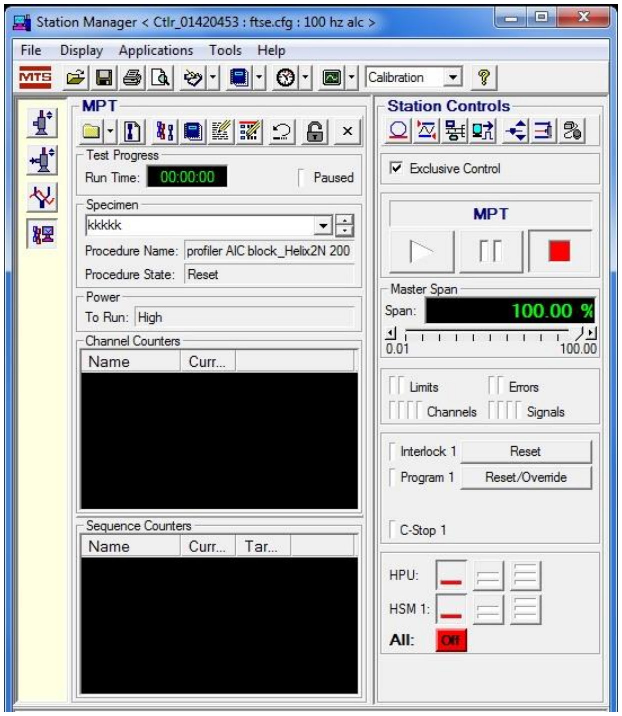

Figure 2: MTS Station Manager Window

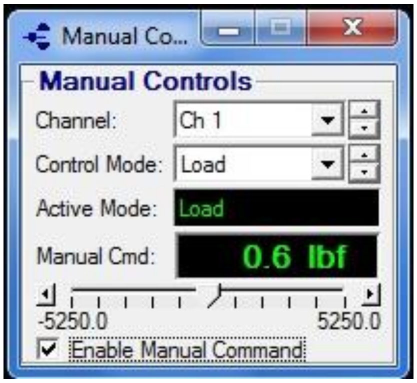

Figure 3: MTS Manual Controls Window

2. Bring up the Manual Controls window (Figure 3) and enable it in Load Control. Set command for 500 lb.

3. Turn on HSM1 and let the hydraulics warm up (Figure 2).

4. Go to Station Setup (Figure 4), click Displacement, click on the top icon, click on Offset/Zero tab, and adjust Manual Offset so that Current Value equals 1.00 in.

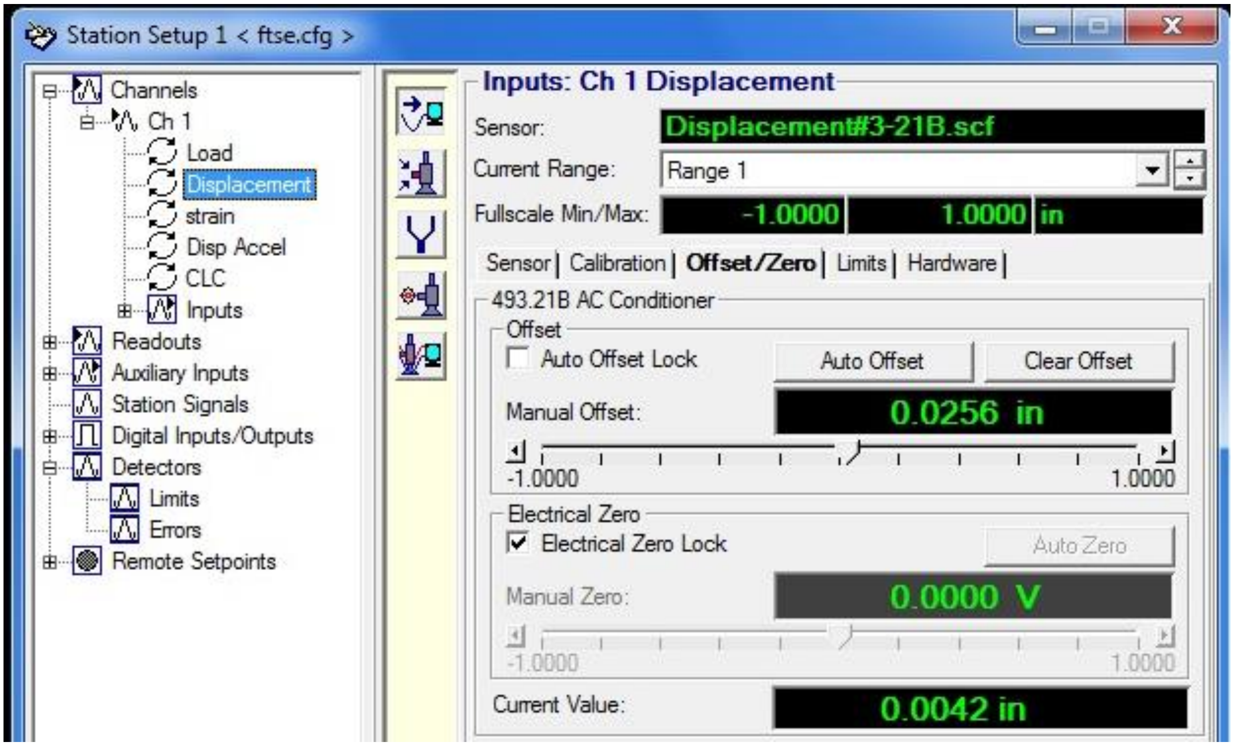

Figure 4: MTS Station Setup Window

5. Now go to Manual Control (Figure 3), change to displacement and set for 0 in. This centers the actuator.

6. Next go to Station Setup (Figure 4), click on Load, click on the top icon, click Offset/Zero, then click Auto Offset. This will zero the load cell.

7. Unlock the Crosshead Lock which will alarm Program 1 interlock and raise the crosshead to top of frame. Press inserts onto specimen and place specimen in bottom grip then close grip. Lower crosshead until specimen is located in top grip, then lock crosshead.

8. On Manual Control window (Figure 3), change to load control and clamp top grip.

9. Put 0 lb load on specimen and reset Program1 interlock on Station Manager (Figure 2).

APPENDIX B
STARTING HIGH-FREQUENCY AXIAL FATIGUE SPECTRUM LOADING

1. Start MTS 793 software and open the configuration file ‘ftse.cfg’ with 100 Hz ALC Parameter Sets selected. Once Station Manager (Figure 5) opens, check Exclusive Control then change Operator to Calibration (password is Calibration).

2. Click on Specimen and enter specimen number (ex: kkkk).

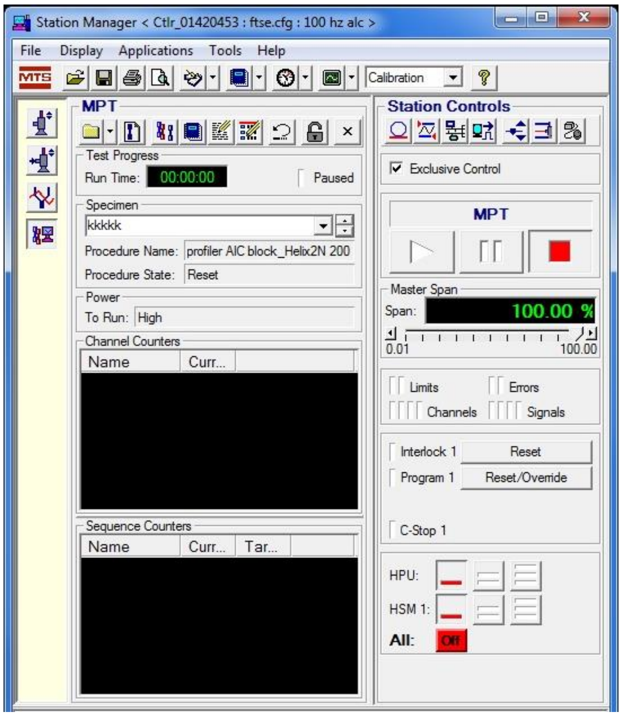

Figure 5: MTS Station Manager Window

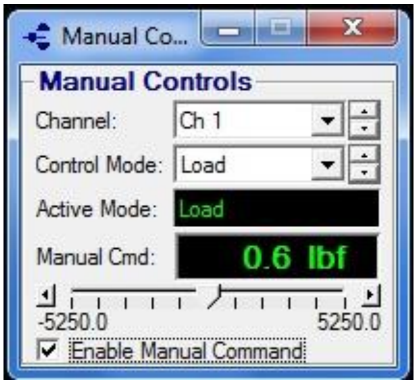

Figure 6: MTS Manual Controls Window

3. Under Stations Manager, click the fifth icon from the left to bring up Manual Controls Window (Figure 6), and check Enable. Next, click the sixth icon from left under MPT (Figure 5). This will bring up MPT Procedure Editor (Figure 7) which is programed for Variable Amplitude. Place all waveforms on the desktop.

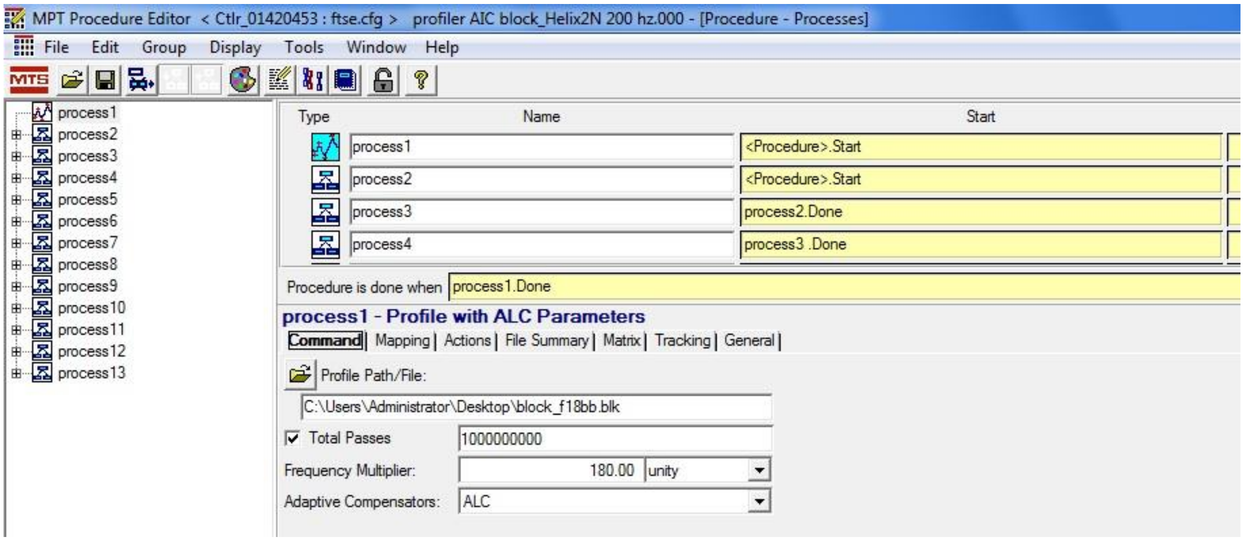

Figure 7: MPT Procedure Editor

4. Now go to Figure 7 and click on Process 1/ Command/ Profile Path, then enter the waveform to be used (ex: block_f18bb.blk). All waveforms must end with .blk format. Set Frequency Multiplier for the frequency in Hz which the test will run at (ex: 180). Next, set the Adaptive Compensators to ALC.

5. Go to the Mapping tab and set Level Multiplier for the max load required for the test.

6. Now click on the Matrix tab (Figure 8) and give the Compensation Matrix a name starting with pp. (ex: pp.jjjj). This is where the learned compensation matrix is stored. If another test is required with the same material (specimen) and the same max load, the pp. file can be copied from the tested specimen file and pasted into the new specimen file but Resume All must be checked on Compensators (Figure 9) until the measured load and command load are close, then check Hold All.

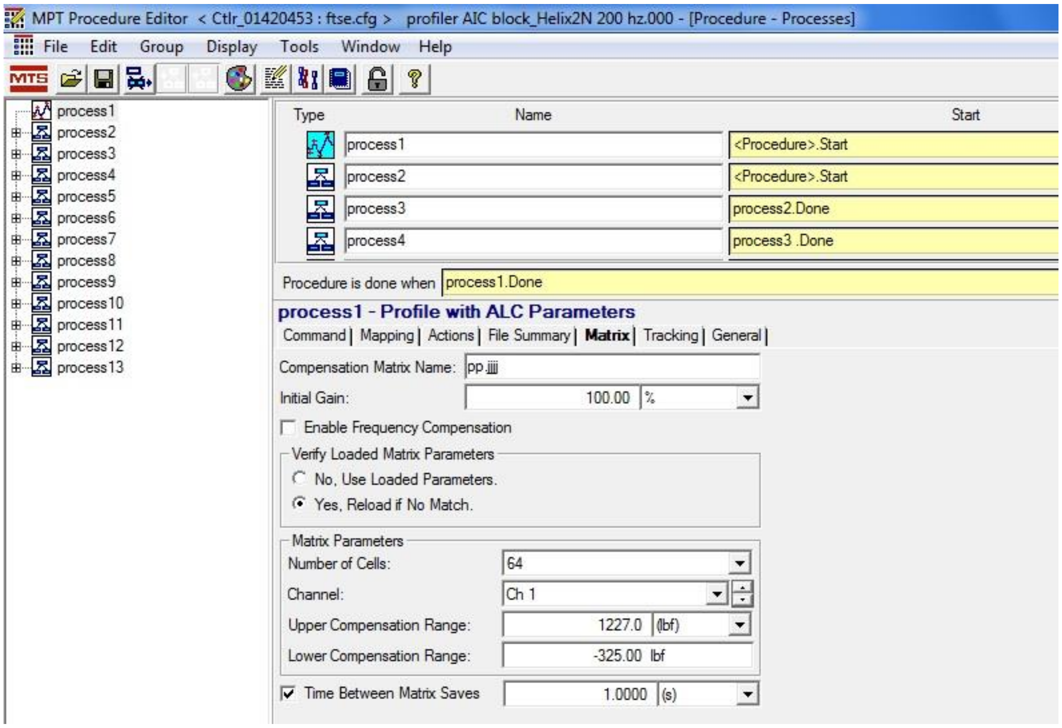

Figure 8: MPT Procedure Editor – Matrix Tab

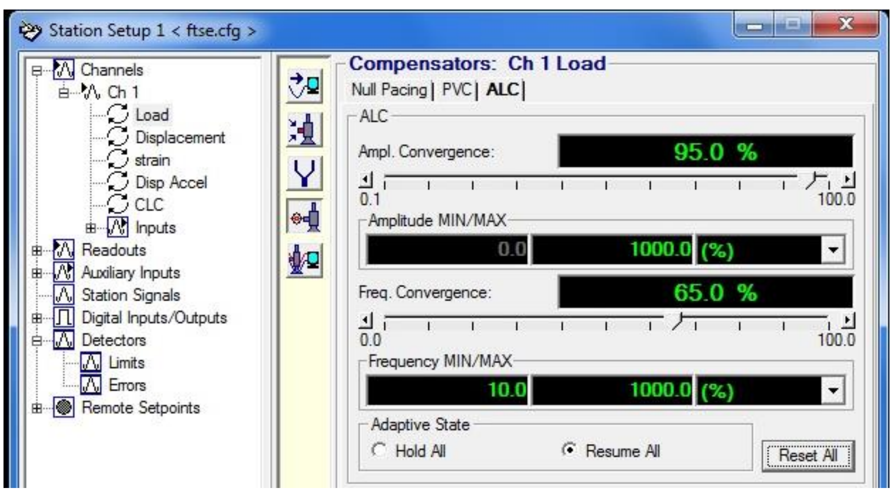

Figure 9: Station Setup – ALC Compensators

7. Continuing on Figure 8, click on the Upper Compensation Range and set for the highest load +100 lb (ex: 1127 lb + 100 lb = 1227 lb) Next click on the Lower Compensation Range and set lowest load +100 lb [ex: -225 lb + (-100 lb) = -325 lb].

8. In Station Setup, click on Detectors Limits (Figure 10). In the Upper Limit tab (Figure 11), change the Ch1 Displacement, Upper Limit to 0.020 in. and the Upper Action to Station Power Off. Set Ch1 Load, Upper Limit for 100 lb above test loads, and Upper Action to

Station Power Off. In the Lower Limit tab (Figure 12) set Ch1 Displacement to -0.020 in. and Lower Action to Station Power Off; Ch1 Load for 100 lb lower than the lowest test load and Lower Action to Station Power Off. When the specimen breaks, the Displacement Limits will turn the hydraulics off.

Figure 10: Limit Detectors Window

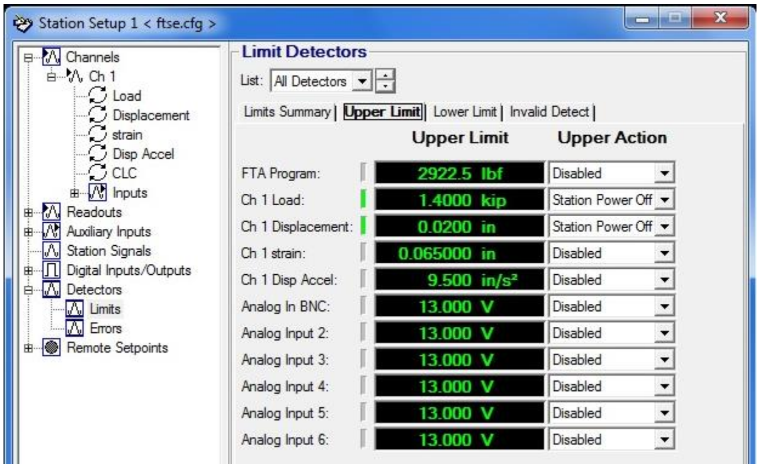

Figure 11: Upper Limit Detectors

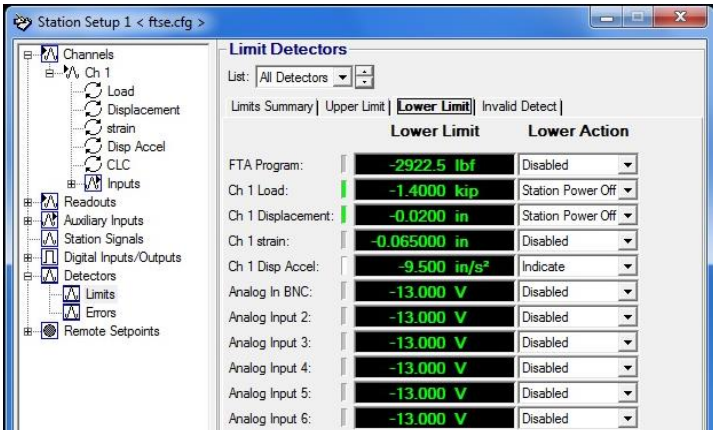

Figure 12: Lower Limit Detectors

9. Now go to Station Manager (Figure 5), click on Display to bring up Meters (Figure 13) and Scope (Figure 14).

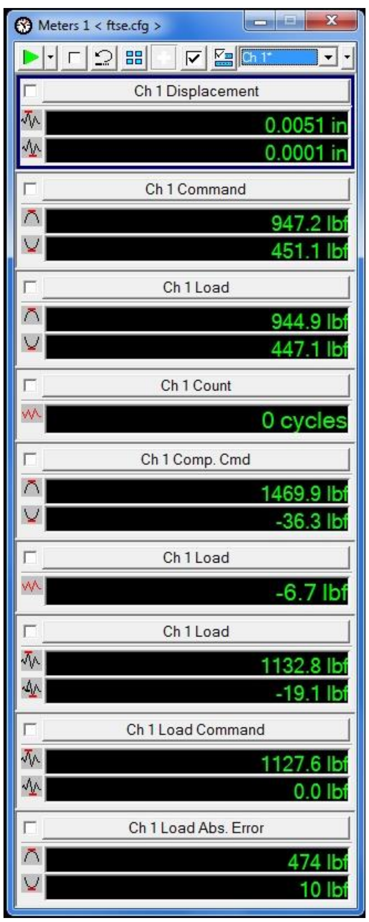

Figure 13: Meters Window

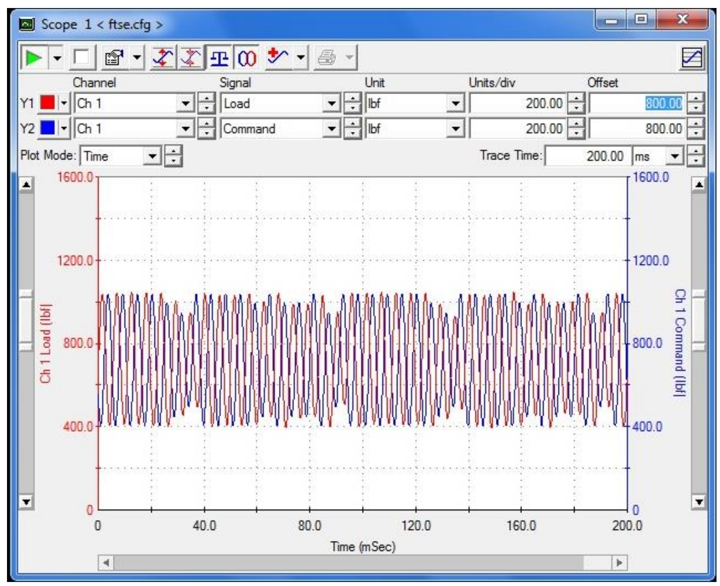

Figure 14: Scope Window

10. Proceed to Tuning.

11. After Tuning, go to (Figure 9) Compensators ALC and check Hold All.

12. Next go to Manual Control (Figure 6) and turn off enable. Go to Station Manager (Figure 5), click on the third icon from right under MPT which Resets Procedure and closes Lock which is the second icon from the right. This allows the test to be started. Go to MPT and click Triangle to start test.

APPENDIX C
TUNING

1. For a spectrum test using ALC compensation, the system controller must be tuned manually. Start by going to Station Setup, Ch 1 Load Adjustments tab (Figure 15) to set P Gain from 1 to 1.5, I Gain from .1 to .8, and D Gain must be kept at 0. Note the tuning parameters shown here are for 7075-T6 aluminum running at 180 Hz.

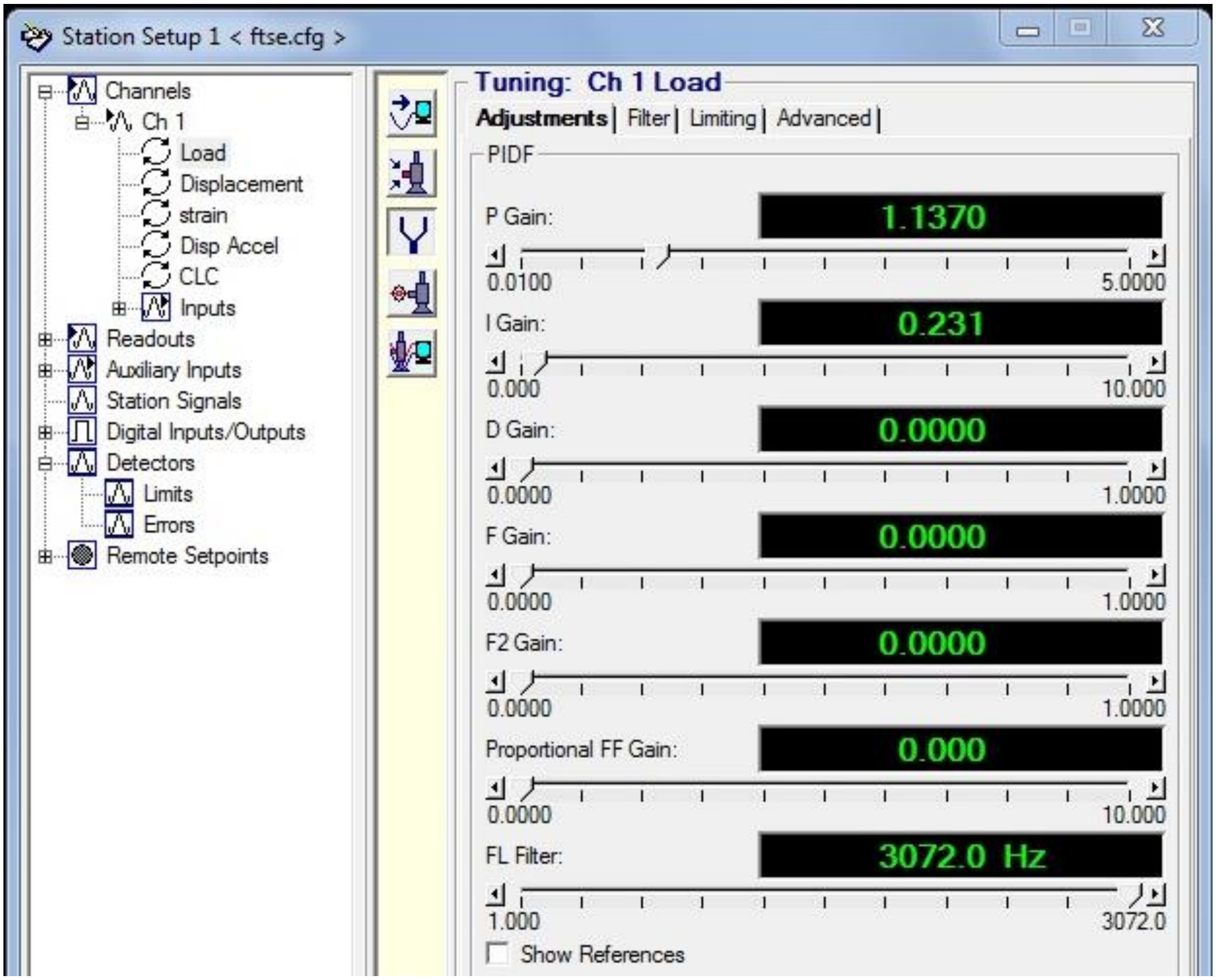

Figure 15: Load Compensation Adjustments

2. Next, go to Inserting Specimen in Test Frame (Appendix A) and install the specimen. For initial tuning purposes, it is advisable to use a dummy test specimen so that a significant number of cycles with large P-V control errors are not accumulated on a good test specimen.

3. Go to ALC Compensators tab (Figure 16), turn on Resume All, and click Reset All.

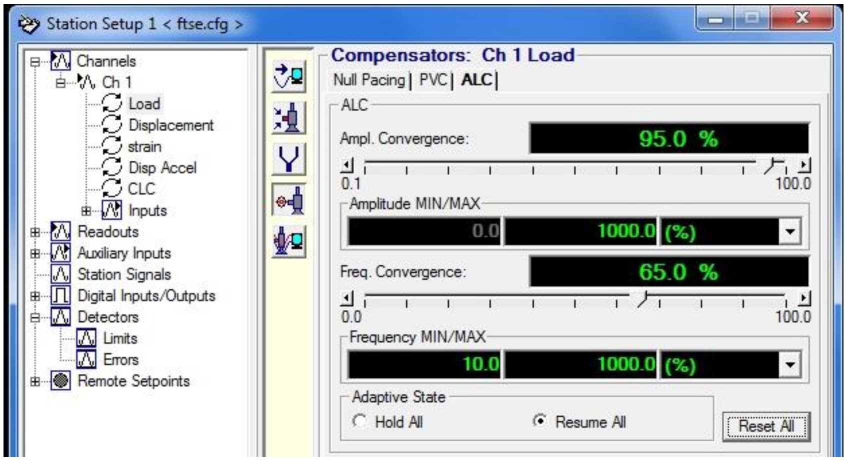

Figure 16: ALC Compensation Tab

4. Bring up Manual Control (Figure 18) enable and set load to zero. Turn off Enable.

5. Switch to Station Manager (Figure 17) click on the third icon from right under MPT to Reset Procedure. The lock second icon from the left will close.

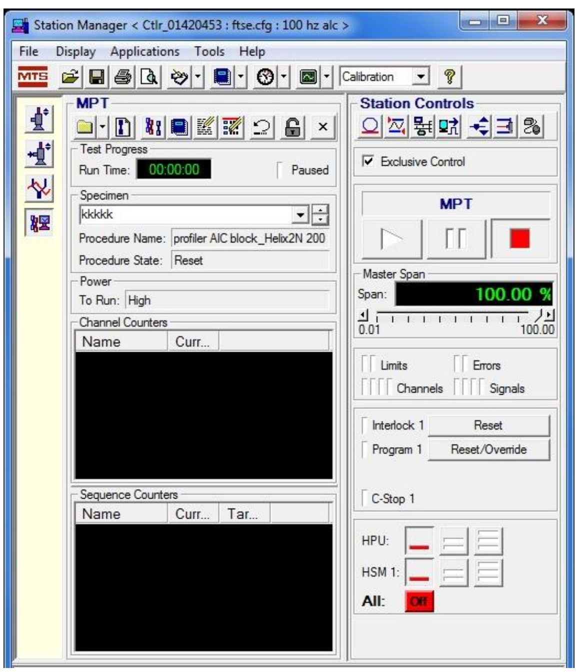

Figure 17: MTS Station Manager Window

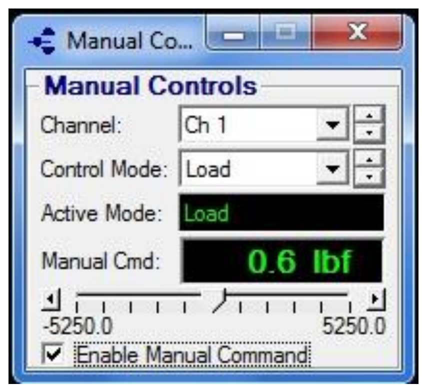

Figure 18: MTS Manual Controls Window

6. Bring up Scope (Figure 20) set up, click Start and bring up Meters (Figure 19), click Start and Reset.

Figure 19: Meters Window

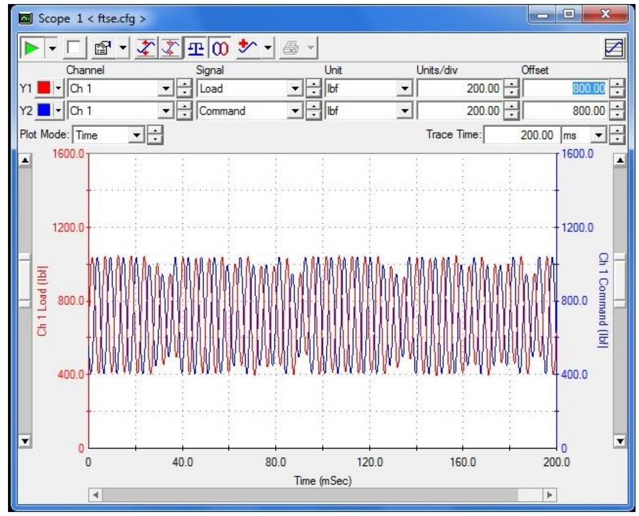

Figure 20: Scope Window

7. Go to Station Manager (Figure 17), click on the white arrow under MPT: this turns red and starts the load cycling. Try to get Load and Load Command on Meters to match as close as possible by adjusting P Gain and I Gain (Figure 15). Allow at least 100,000 cycles between each change of P and I Gain.

8. Stop cycling before making any changes to the Gains. In Station Manager (Figure 17), click the square under MPT, then click the Closed Lock second icon from right under MPT which will open and allow changes. Bring up Manual Control (Figure 18), check Enable, set load to zero, and uncheck Enable. After changing the gain settings, go to ALC Compensators tab (Figure 16) and click Reset All. Next, go to Station Manager (Figure 17), click Reset Procedure, and click Start. This must be done each time a change is made in any of the gain settings.

9. When the tuning is completed, click Stop on Station Manager (Figure 17), go to the second icon from right under MPT and click Lock, which will open. Bring up Manual Controls (Figure 18), click Enable, and set the load to zero.

10. Go back to High Frequency Axial Fatigue Spectrum Loading (Appendix B).

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APPENDIX D
TEST DATA RECORDING

1. The data recording is controlled using Processes 2-13 under MPT Procedure Editor. Half Hour or Count is the starting cycle for taking data (Figure 21).

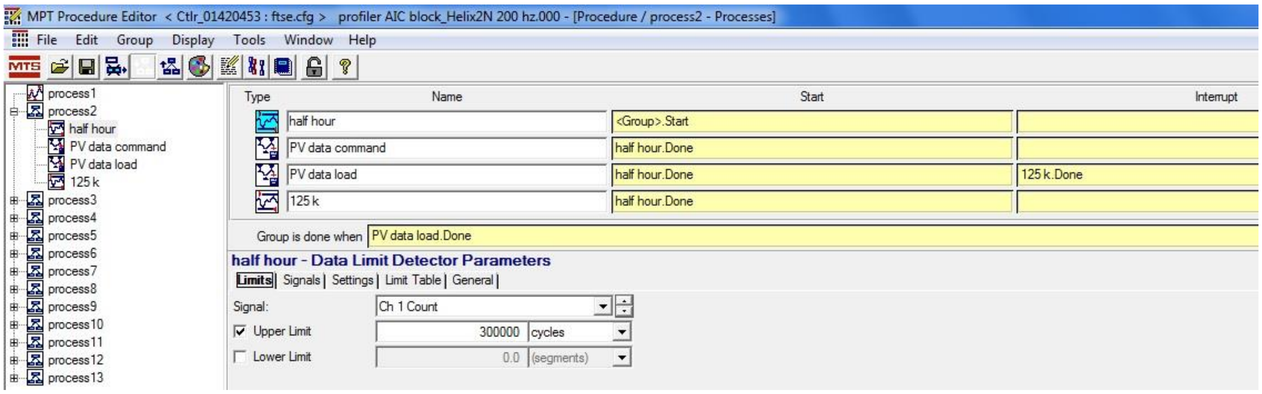

Figure 21: MPT Data Recording Process

2. PV data command Acquisition (Figure 22) is the P-V load command input data which are the Signals count (Figure 23) and load command stored on user-specified data file Command.data (Figure 24).

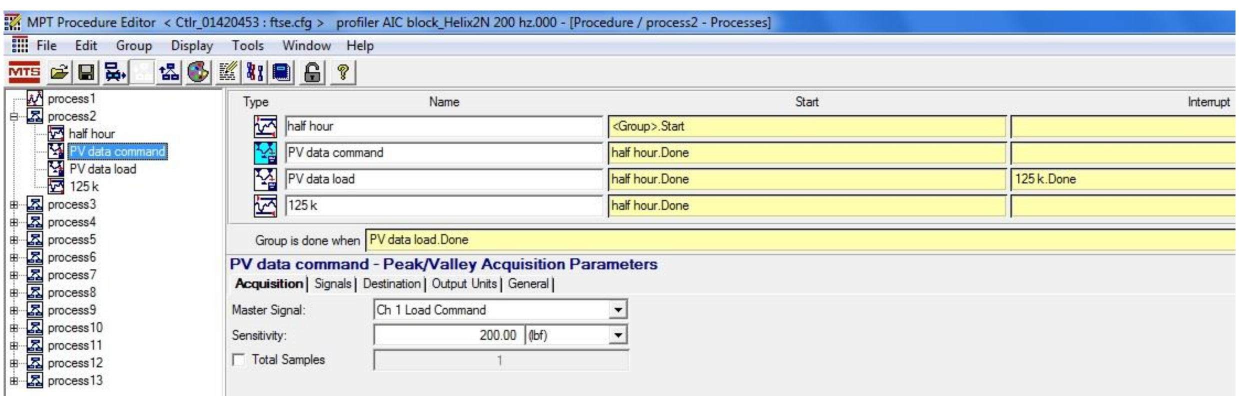

Figure 22: PV Data Command Acquisition

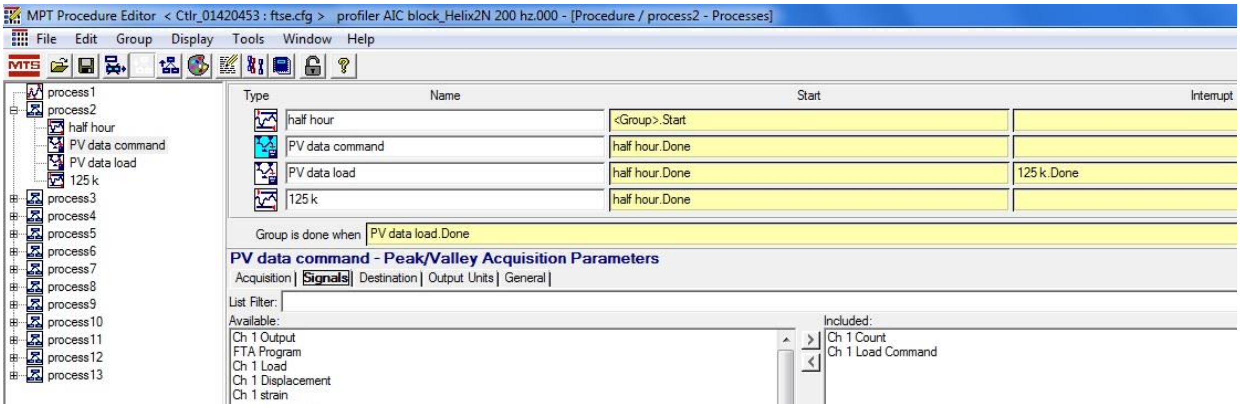

Figure 23: PV Data Command Signals

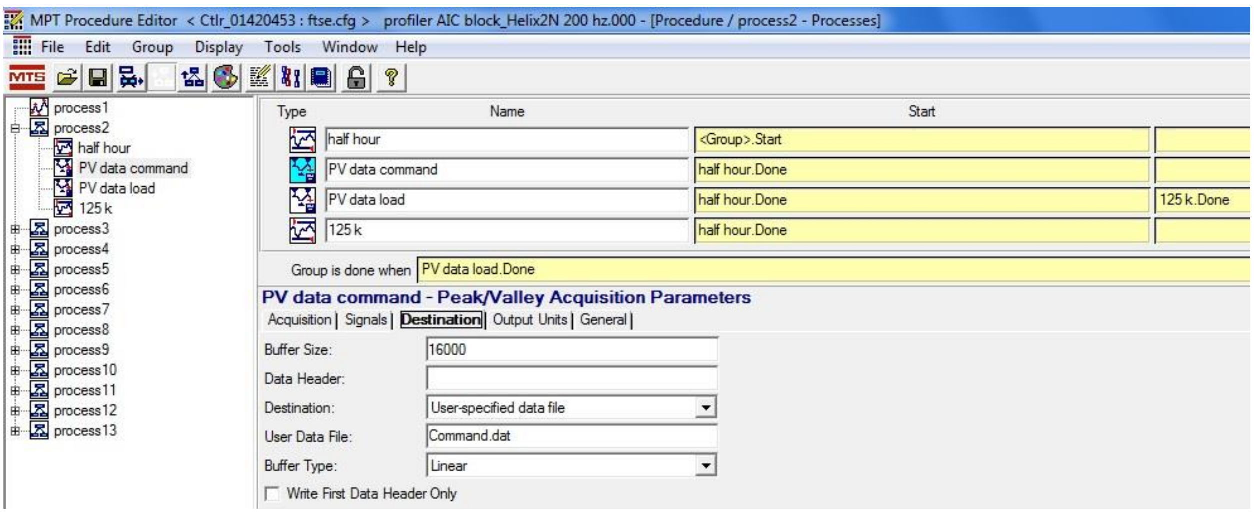

Figure 24: PV Data Command Destination

3. PV data load Acquisition is the P-V load response output which consists of the Signals count and load stored on user specified data file Load.dat. These menus are similar to the ones shown for PV data load in Figures 22-24. The final cycle count for taking data is 125K. The starting cycle and final cycle can be adjusted in Processes 2-13.

DISTRIBUTION

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